Biogeography of Indonesian Mountain Weasel *Mustela lutreolina* and a newly discovered specimen

Shai MEIRI[1], J. W. DUCKWORTH[2] and Erik MEIJAARD[3]

Abstract

A previously undocumented specimen of Indonesian Mountain Weasel *Mustela lutreolina* from Java was previously ascribed, incorrectly, to Malay Weasel *M. nudipes*. The re-identification is based on a decisive cranial feature, and is consistent with known distributions of the two species. The addition of this specimen brings the total number of wild caught specimens in museums to 12. Using all known distribution data of *M. lutreolina*, we draw a tentative distribution map and hypothesise about its biogeographic history and population status.

Keywords: Sumatra, Java, cranial traits, conservation status, distribution, evolutionary history, last glacial maximum

Abstrak

Disini kami melaporkan tentang keberadaan suatu spesimen Musang Gunung Indonesia *Mustela lutreolina* dari Jawa. Sebelumnya, spesimen tersebut diklasifikasikan sebagai spesies lain, yaitu *M. nudipes*. Pengidentifikasian kami, didasarkan pada aspek-aspek tenkorak yang karakteristiknya untuk spesies tersebut. Klassifikasi juga sesuai dengan pengetahuan tentang distribusi dua spesies musang ini. Dengan masuknya spesimen baru, jumlah spesimen untuk *M. lutreolina* di dalam koleksi museum sakarang mencapai 12. Berdasarkan semua data tentang distribusi Musang Gunung Indonesia, kami menggambarkan peta distribusi dan membuat hipotesis tentang sejarah biogeografi spesies ini dan status populasinya.

Introduction

Assessing past or expected population trends of mammals is a commonly used method to determine their risk of extinction (IUCN 2006). Many mammals however, especially in tropical countries, are poorly known. Distribution ranges, ecology, and population trends are often inferred from a handful of sightings and/or specimen records, and assumptions about exploitation and habitat loss. Often more data are available on species distribution than would be revealed by a study of texts alone (e.g. Meijaard & Nijman 2003). It is especially important to review museum specimens and check with field workers about their knowledge of a particular species. One species in need of a reassessment is the Indonesian Mountain Weasel *Mustela lutreolina*. It was classified by the IUCN Red List as Endangered in 1996, based on the assumption that its distribution was small and fragmented (IUCN 1996), and this listing has not subsequently been changed. We reassess this status based on new specimen information, a new field record, and inference from biogeography.

Only 15 specimens of *M. lutreolina* have been collected, (including three zoo specimens; Table 1), at altitudes between 1,450 and 2,200 m a.s.l. A recent sighting was made at 3,000 m a.s.l. (Holden 2006). A message we have posted on the online Indonesian Nature Conservation newsletter (in Indonesian and English), which reaches about 2000 conservationists, NGOs, academics etc., asking for any records of the weasel, returned no report of anyone who had seen the species. Remarkably, no females are known among the specimens.

The additional specimen

The fifteenth specimen, previously ascribed to the Malay Weasel *M. nudipes*, is published here for the first time. The specimen, #48082, Museum für Naturkunde, Humboldt Universität zu Berlin, comes from the Ijang (= Jang, on original documentation) plateau, East Java (7°59′S, 113°40′E), 2,300 m a.s.l.

The skull is part of a batch of eight specimens (BZM 48080–48085 and 48089–48090) which share a batch number (1.9.36) in the museum's Katalog (=accessions register). There are no field tags on any of the skins in the batch, and by the first specimen (#48080, a Moonrat *Echinosorex gymnurus*) is written "auf Wünsch des Gebers, soll sein Namen auf den Objekten nicht verzeichnet sein" (= at the wish of the giver, his name should not be recorded on the specimens). The skull is annotated, in ink, with "♂ 48082 Jang Plateau, 2300 m, Ost Java, Jan 1935"; added in a later pen is "M[ustela] nudipes". Whatever the reason a donor might request anonymity, today the chief concern is that potentially the locality information might be in error. If, for example, the collector received the specimen from a local resident, the locality could reflect where the resident lived, rather than where the animal was collected. In this case, the skull's associated data seem reliable. The eight animals in the batch are recorded with various sites, dates and altitudes across Indonesia suggesting that the specific origins attributed to each are likely to be correct; in particular, altitudes are rarely given for historical specimens taken from markets or expatriate houses. The museum accessions register gives the collector as Paul Friedrich Franck, and some lettering, which looks as if it might well have been "P. F. Franck" has been scrubbed off the skull. The several skins in the batch have also had some of the original writing on the specimen tag (added by the museum) scratched out, in the space for collector name, indicating that the request for anonymity was for all specimens in the batch, rather than any particular one. The museum's card index to specimens gives no collector for the weasel, but for two Yellow-throated Martens *Martes flavigula* in the batch, also from the Ijang plateau (from 27 November 1935), "Dorries / Franck S.

Table 1. Known specimens and sight records of Mustela lutreolina.

Museum (specimen #)	Island	Locality	Elevation m a.s.l.	Latitude S	Longitude E	Sex	Year collected	Remarks
RMNH (7181)	Java	Ijang Plateau	2,200	7°59′	113°46′	Male	1932	van Bree & Boeadi 1978
RMNH (7182)	Java	Ijang Mt.	2,200	7°59′	113°46′	Male	1932	van Bree & Boeadi 1978
MZB (6749)	Java	Ijang Highlands	2,000	7°59′	113°46′	Male	1932	van Bree & Boeadi 1978
ZMB (48082)	Java	Ijang Plateau	2,300	7°59′	113°46′	Male	1935	*This study*
RMNH (14649)	Java	Kaligua Estate on Mt. Slamet	1,500	7°08′	109°07′	Unsexed	1929	Bartels 1937
MZB (278)	Java	Sukawana, Mt. Tankubanprahu	1,500	6°44′	107°36′	Male	1918	van Bree & Boeadi 1978
RMNH (26107)	Java	Tjiboeni, Bandoeng	1,400	7°11′	107°19′	Male	1932	Sody 1949, Becking 1989
MZB (8433)	Java	Cibodas	1,450	6°48′	106°56′	Male	1958	van Bree & Boeadi 1978
NHM (17.8.4.2)	Java	Cibodas	1,650	6°48′	106°56′	Male	1916	Holotype; Robinson & Thomas 1917
AMNH (106670)	Sumatra	Mount Dempo	1,800	4°01′	103°04′	Male	1936	Lunde & Musser 2003
MZB (6768)	Sumatra	Mount Dempo	1,800	4°01′	103°04′	Male	1941	van Bree & Boeadi 1978
RMNH (a)	Sumatra	Bengkulu District	unk.	3°20′	102°18′	Unsexed	1865	Jentink 1892 as *Mustela henrici* Westerman
MZB (12000)	unk.	unk.	unk.	unk.	unk.	Male	1977	van Bree & Boeadi 1978, Jakarta Zoo
MZB (12001)	unk.	unk.	unk.	unk.	unk.	Male	1977	van Bree & Boeadi 1978, Jakarta Zoo
Captive live animal	unk.	unk.	unk.	unk.	unk.	Unsexed	1980s	Schreiber et al. 1989, Centre for Tropical Biology, near Bogor
Field sighting	Sumatra	Mount Kerinci, Kerinci–Seblat National Park	3,000	2°09′	101°30′	Group of four	July 1995	Holden 2006
Unconfirmed								
Faeces seen in the field	Java	Lawu	3,000	7°37′	111°11′	Unsexed	1930s	Bartels 1937
Faeces seen in the field	Java	Slamet	2,000	7°14′	109°12′	Unsexed	1930s	Bartels 1937

Museum acronyms: MZB – Museum Zoologica Bogoriensis, Bogor, Indonesia; NHM – Natural History Museum, London, UK; RMNH – Nationaal Natuurhistorisch Museum, Naturalis, Leiden, the Netherlands; ZMB – Museum für Naturkunde, Humboldt Universität zu Berlin, Germany; AMNH – American Museum of Natural History, New York, USA. unk. – unknown.

G." has been added to the card, with a modern ball-pen, in Dr R. Angermann's distinctive hand. "S. G." stands for collector and giver; Franck was a collector-naturalist (see, e.g., Franck 1934) who lived for some time in Bogor, West Java, from where access

to the Jiang plateau would have been relatively easy. Dorries was a specimen dealer in Hamburg, who presumably routed the batch to the Berlin Museum (I. Thomas verbally 2006).

There were two reasons to check carefully that the identification of skull 48082 (hereafter "the Berlin specimen") is *M. nudipes*: first, an elevation of 2,300 m is outside the known range of this latter species (0–1,700 m; Duckworth *et al*. 2006), but is well within the range of *M. lutreolina* (1,400–3,000 m, Table 1). An altitude of 2,200 m is ascribed to two RMNH specimens (#7181 and 7182) from the same locality as the Berlin specimen. Secondly, although the type locality of Malay Weasel was originally given as Java (Desmarest 1822), this location was soon doubted (Vigors 1830), and no undoubted Javan records of *M. nudipes* were traced by Duckworth *et al*. (2006). However, *M. lutreolina* is well known to inhabit Java and, in fact, three of the 13 previously known specimens with locality data for *M. lutreolina* are from the Ijang area (Table 1).

Mustela lutreolina and *M. nudipes* are easily distinguished by their skins. The former is dark brown, the latter brightly coloured, usually orange, with a white head. The Berlin specimen does not have an associated skin and we therefore compared its skull with those of *M. lutreolina* and *M. nudipes* at the American Museum of Natural History, New York, and at the Natural History Museum, London.

The skull sizes of these two species are very similar, and the Berlin specimen size is well within the variation in both species (S. M. unpublished). There is, however, a good taxonomic character in the skull: *M. lutreolina* has a foramen in the medial part of the auditory bullae, mid-way along the anterior–posterior axis, at the point where the bullae attach to the skull (Abramov 2000). In most specimens of *M. nudipes* we examined (five out of eight) there is no such feature. In some (e.g. NHM 55.1595, AMNH 106065), there is a hint of one; but it is never clear cut and does not penetrate the bulla wall. In both *M. lutreolina* studied (AMNH 106670, and the holotype, NHM 17.8.4.2), as well as in the Berlin specimen, the foramen is well distinguished and penetrates the bulla wall (Fig. 1). On the basis of this cranial character the Berlin specimen is evidently a formerly unrecognised specimen of *M. lutreolina*. The geographical and altitudinal origin support this view.

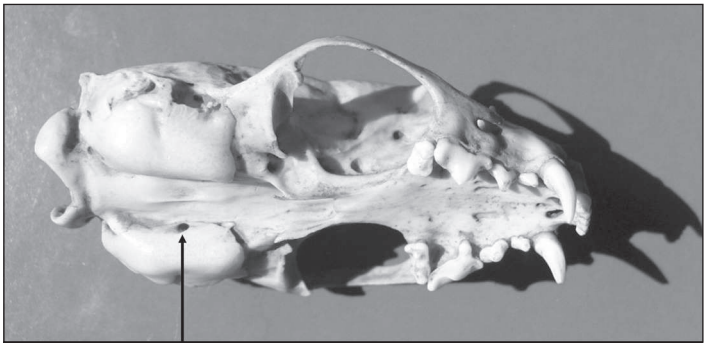

Fig. 1. The posterior margin of the Berlin specimen. The foramen is clearly seen in the middle of the bulla (arrow).

Biogeography

Available data allow some speculation on the evolution and biogeography of *M. lutreolina*, which lacks a fossil record. It is plausible that it arrived in Java and Sumatra during one of the more severe glacial periods, when land connections between those areas and mainland Asia might have supported suitable habitat. During the last glacial maximum, for instance, montane forest vegetation boundaries were lowered markedly in both Java and Sumatra (van der Kaars & Dam 1997, Stuijts *et al*. 1988). If *M. lutreolina* requires conditions found in montane areas, the lowering of the boundaries of montane vegetation types would have increased its dispersal opportunities from today's Asian mainland to the present range. Subsequently, the species would have been restricted to higher elevations during inter-glacial phases. Bininda-Emonds *et al*. (1999) estimated that the divergence between some of the South-east Asian *Mustela* species (*M. lutreolina*, *M. nudipes*, *M. sibirica* and *M. strigidorsa*) happened approximately 200,000 years ago. Marmi *et al*. (2004) suggested that *M. sibirica*, to which *M. lutreolina* appears most closely related (van Bree & Boeadi 1978), diverged from some other Eurasian species (*M. itatsi*, *M. lutreola*, *M. eversmannii* and *M. putorius*) between 700,000 and 400,000 years ago. *Mustela lutreolina* would then be a Late Pleistocene arrival on Java and Sumatra that had probably dispersed to the island during the penultimate or last glacial maximum (135 or 22 thousand years ago; van Bree & Boeadi 1978).

Javan records for *M. lutreolina* (Fig. 2) are well spread across the mountain areas of the island, but it remains unclear whether the species is restricted on Sumatra to the south, or has been overlooked in central and north Sumatra. Only three Sumatran specimens and one field sighting (Holden 2006) are known, and deducing a range restriction from this would be rash. Recent works have significantly extended the known ranges for other South-east Asian *Mustela* species (e.g. *M. kathiah*, Duckworth & Robichaud 2005; *M. nudipes*, Duckworth *et al*. 2006; *M. strigidorsa*, Abramov *et al*. in prep.). There does not seem to be an obvious mechanism for restricting species to southern Sumatran mountains. The Bukit Barisan mountain chain runs almost uninterrupted along the length of Sumatra. Only the area south of Lake Toba (Fig. 2) is lower and appears to be a faunal break for some species (Whitten *et al*. 1987). Further surveys in northern and central Sumatra are needed to define range limits of *M. lutreolina*.

Next to nothing is known about the natural history of Indonesian Mountain Weasel, and its conservation status was changed from Insufficiently Known (the precursor category for today's Data Deficient) to Endangered in 1996, with no new data or insight to support this designation. The scarcity of museum specimens is combined with a paucity of recent direct field sightings (quite possibly only that of Holden 2006).

Conservation

Indonesian Mountain Weasel was classified as endangered under the IUCN criteria B1 and B2c (IUCN 1996). This implies the Extent of Occurrence estimated to be less than 5,000 km² or the Area of Occupancy estimated to be less than 500 km² (criterion B) and the two following criteria:

1. Severely fragmented or known to exist at no more than five locations (B1).
2. Continuing decline, inferred, observed or projected, in area, extent and/or quality of habitat (B2c).

Relatively few biologists visit the altitudinal range of *M. lutreolina*, hampering assessment of its conservation status. Based on the altitude of museum specimens (Table 1), we calculated the 95% confidence interval for the altitudinal range of *M. lutreolina*

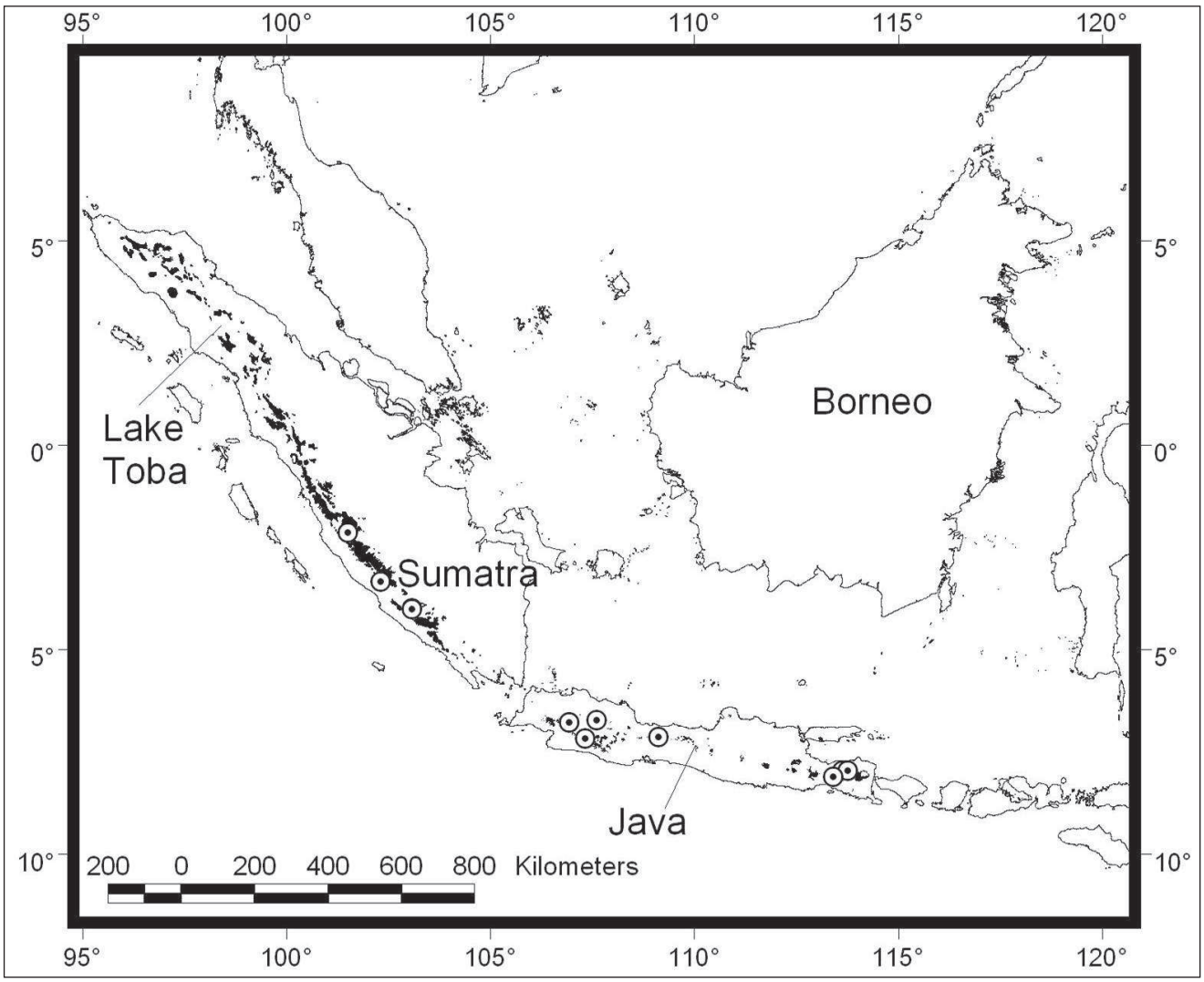

Fig. 2. Specimen localities or direct sightings of M. lutreolina *(circles). Black areas are areas on Java and Sumatra >1,000 m a.s.l.*

as 1,060–2,540 meters a.s.l. We therefore used an available 1,000 m contour map to create a tentative distribution map (Fig. 2).

The altitude data indicate that the geographic range of the Indonesian Mountain Weasel could be between 3,000 and 30,000 km^2, depending on whether only the mountains where the species was collected, or all areas > 1,000 m a.s.l. in Java and Sumatra, are included. On Java, even the maximum range is highly fragmented, but it is much less so in Sumatra, which has a north-west–south-east trending backbone with contiguous land over 1,000 m. There are too few habitat data to determine whether this weasel could inhabit all land over its minimum altitude, or whether only certain habitats are used.

Since the early 1990s montane forests on Java and Sumatra have been increasingly affected by deforestation. On Java, forest clearance on the volcanic slopes has reached its highest rates since the colonial period, mainly because of illegal logging in state forests and increased forest fires (Lavigne & Gunnell 2006). Conversion of montane forests, e.g. for coffee plantations, is rapidly increasing in southern Sumatra. Deforestation occurs at higher rates in state forests, including national parks, than in forests owned by communities (Kinnaird *et al*. 2003), indicating that protected area status is unlikely to reduce deforestation in the short term. It is unclear how dependent *M. lutreolina* is on forested habitats. Holden (2006) observed it above the tree line, and although other localities are lower, there is no specific information as to whether animals came from forest or open habitats. It is therefore unclear how the weasel is affected by deforestation.

Thus while *M. lutreolina* might justly be classified under criterion B1 if it was a Javan endemic, its Sumatran range is unlikely to be severely fragmented (Fig. 2) unless it has very precise microhabitat use (for which there is no suggestion). There are also no data that imply continuing decline in area, extent and/or quality of habitat. Thus criterion B2c is not met. Nor are there any data to imply any decline in population size that would classify the species as endangered under the IUCN population trend criteria for extinction risk. Although the extreme paucity of records of *M. lutreolina* might combine with a highly fragmented range and might therefore mean the species is rare, and field studies might prove it is declining, no data support this at the present moment, or even can be used to infer it. We therefore recommend the species status should be changed to Data Deficient until a study of actual habitat preferences and/or population status is carried out.

Conclusions

Mustela lutreolina is still very poorly known and may be underdetected because of lack of surveys at high altitudes. Although habitat in its altitudinal range is facing anthropogenic conversion,

the significance of this to the weasel is unclear. Nearly 20 years ago the chief conservation recommendation for *M. lutreolina* by Schreiber *et al*. (1989) was for "field work...to locate populations...and to assess their conservation status and requirements". This remains an appropriate prioritisation today. Each part of the species's range, Java and Sumatra, was identified as a "Core area for mustelid and viverrid conservation" (and only seven such areas were identified globally) by Schreiber *et al*. (1989). In the intervening period ongoing forest loss and wildlife trade trends increase the urgency for accurate status information on the small carnivores of these two areas.

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[1]NERC Centre for Population Biology, Imperial College London, Silwood Park Campus, Ascot, UK.
Email: s.meiri@imperial.ac.uk

[2]Wildlife Conservation Society Asia Program, New York, USA.

Present address:
East Redham Farm, Pilning, Bristol, BS35 4JG, UK.

[3]The Nature Conservancy–East Kalimantan Program, Samarinda, Indonesia and School for Archaeology and Anthropology, Australian National University, Canberra, ACT 0200, Australia.